Amendments to the Claims

Please amend the pending claims as follows:

1. (currently amended) An apparatus for monitoring in real time the movement of a plurality of substances in a mixture, having at least one fluid layer, along an axis of flow within a tube, the apparatus comprising:

an X-ray scanner, wherein said X-ray scanner performs a plurality of scans of the mixture over a monitoring period to produce a plurality of scans, wherein a plurality of scan data sets are derived from said scans and wherein said X-ray scanner comprises ~~a sensor array having at least two image rings, each of said image rings arranged serially along an axis of flow;~~

an annular X-ray tube positioned radially outward from said tube wherein said annular X-ray tube has a plurality of X-ray sources;

an annular sensor array radially positioned between said annular X-ray tube and said tube wherein said annular sensor array comprises a plurality of sensors arranged in a plurality of rings,

wherein said X-ray sources sequentially emit radiation and wherein each X-ray source directs said emitted radiation toward a portion of said sensor array positioned furthest from said X-ray source and past a portion of said sensor array positioned nearest to said X-ray source; and

control means arranged to analyze the scan data sets to identify volumes of each of the substances and to measure their movement.

2. (previously presented) The apparatus according to claim 1 wherein the apparatus produces a scan data set relating to said at least one fluid layer of the mixture.

3. (previously presented) The apparatus according to claim 2 wherein the control means determines a plurality of volume elements in said layer and uses a measure of X-ray attenuation in each of said volume elements to form the scan data set.

4. (previously presented) The apparatus according to claim 2 wherein the control means uses the scan data sets to determine an amount of at least one of the substances in said at least one fluid layer.

5. (previously presented) The apparatus according to claim 4 wherein the control means uses the scan data sets from each of the scans to determine a time averaged value of the amount of said at least one substance.

6. (previously presented) The apparatus according to claim 2 wherein the control means produces scan data sets relating to more than one layer~~s~~ of the mixture, wherein the layers are in different positions from each other.

7. (previously presented) The apparatus according to claim 6 wherein the control means is arranged to use the scan data sets relating to said plurality of layers to measure movement of at least one of the substances.

8. (previously presented) The apparatus according to claim 7 wherein the control means is arranged to track a movement of regions of said substance through the plurality of layers to determine a flow velocity of said substance.

9. (previously presented) The apparatus according to claim 1 wherein the control means is used to measure a movement of a region of a first substance, to determine a measure of the buoyancy of said region relative to at least one other substance, and to measure a movement of said at least one other substance using the movement of said region.

10. (previously presented) The apparatus according to claim 1 wherein the control means calculates a parameter of movement of the plurality of substances to produce a measured value of the parameter from the scan data sets.

11. (previously presented) The apparatus according to claim 1 wherein the control means is used to determine a flow rate of at least one of the substances.

12. (previously presented) The apparatus according to claim 1 wherein the control means is used to analyze a scan data set in two stages, wherein a first stage provides a relatively lower spatial resolution and higher contrast resolution.

13. (canceled)

14. (canceled)

15. (previously presented) The apparatus according to claim 1 wherein the scanner is placed around a pipe to measure the movement of the substances through the pipe.

16. (previously presented) The apparatus according to claim 1 further comprising display means for displaying an image of the mixture generated by the control means.

17. (previously presented) The apparatus according to claim 16 wherein the display means displays a video image of the mixture.

18. (currently amended) A method of monitoring in real time the movement of a plurality of substances in a mixture within a tube, the method comprising:

performing a plurality of X-ray scans of the mixture over a monitoring period to produce a plurality of scans wherein a plurality of scan data sets are derived from said scans and wherein said X-ray scans are performed using an X-ray scanner comprising~~a sensor array having at least two image rings, each of said image rings arranged serially along an axis of flow~~

an annular X-ray tube positioned radially outward from said tube wherein said annular X-ray tube has a plurality of X-ray sources;

an annular sensor array radially positioned between said annular X-ray tube and said tube wherein said annular sensor array comprises a plurality of sensors arranged in a plurality of rings,

wherein said X-ray sources sequentially emit radiation and wherein each X-ray source directs said emitted radiation toward a portion of said sensor array positioned furthest from said X-ray source and past a portion of said sensor array positioned nearest to said X-ray source; and

analyzing the data sets to identify volumes of each of the substances and to measure their movement.

19. (previously presented) A method according to claim 18 wherein each scan produces a scan data set relating to a layer of the mixture.

20. (previously presented) A method according to claim 19 further comprising defining a plurality of volume elements in said layer and using a measure of the X-ray attenuation in each of said volume elements to form the scan data set.

21. (previously presented) A method according to claim 20 wherein the scan data sets are used to determine an amount of at least one substance in said layer of the mixture.

22. (previously presented) A method according to claim 21 wherein the scan data sets are used to determine a time averaged value of the amount of said at least one substance.

23. (previously presented) A method according to claim ~~19~~ 18 wherein said scan data sets are produced relating to a plurality of layers of the mixture, wherein the layers are in different positions from each other.

24. (previously presented) A method according to claim 23 wherein the scan data sets relating to said plurality of layers are used to measure movement of at least one of the substances.

25. (original) A method according to claim 24 wherein the movement of regions of said substance through the plurality of layers is tracked to determine a flow velocity of said substance.

26. (previously presented) A method according to claim 18 wherein movement of a region of a first substance is measured, a measure of the buoyancy of said region relative to at least one other substance is determined, and the movement of said at least one other substance is measured using the movement of said region and said buoyancy.

27. (canceled)

28. (previously presented) A method according claim 18 comprising the step of determining a flow rate of at least one of the plurality of substances.

29. (previously presented) A method according to claim 18 comprising the step of analyzing the scan data set in two stages, wherein one stage provides a relatively lower spatial resolution and higher contrast resolution.

30. (previously presented) A method according to claim 29 further comprising the step of identifying volumes of a first of said substances using the higher spatial resolution analysis and using the higher contrast analysis to distinguish between volumes of two further substances.

31. (previously presented) A method according to claim 30 further comprising the step of using the high spatial resolution analysis to adjust a measure of X-ray attenuation of volume elements defined in the low spatial resolution analysis.

32. (previously presented) A method according to claim 18 further comprising the step of placing the scanner around a pipe to measure the movement of the substances through the pipe.

33. (canceled)

34. (canceled)

35. (previously presented) The apparatus according to claim 1 wherein the control means uses a higher spatial resolution analysis to identify a volume of a first substance.

36. (previously presented) The apparatus according to claim 1 wherein the control means uses a higher contrast resolution analysis to distinguish between a volume of a first substance and a volume of a second substance.

37. (previously presented) The apparatus according to claim 1 wherein the control means uses a high spatial resolution analysis to adjust a measure of X-ray attenuation of volume elements defined in a low spatial resolution analysis to account for the presence in said volume elements of a first substance.

38. (previously presented) The apparatus according to claim 1 wherein the control structure generates a high resolution image comprising a plurality of pixels.

39. (previously presented) The apparatus according to claim 38 wherein the high resolution image is segmented.

40. (previously presented) The apparatus according to claim 39 wherein a binary segmentation process is used to segment the high resolution image.

41. (previously presented) The apparatus according to claim 38 wherein the high resolution image is segmented to determine which of said pixels represent a gas phase and which of said pixels represent a liquid phase.

42. (new) The apparatus according to claim 1 wherein said annular X-ray tube and said annular sensor array completely encompass said tube.

43. (new) The apparatus according to claim 1 wherein said annular X-ray tube and said annular sensory array partially encompass said tube.